MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

PGC0225 – GENERAL CHEMISTRY

(Foundation in Life Sciences students only)

7 March 2020
2.30 p.m – 4.30 p.m

(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **5** pages with **5** questions only.
2. Answer **ALL** questions.
3. Please write all your answers in the answer booklet provided.
4. Distribution of marks for each question is given.
5. Calculator is permitted.

Instructions: Answer **ALL** questions.

Question 1 [10 marks]

a. The highly exothermic thermite reaction is used to weld together the steel rails of railway tracks. It involves the reduction of iron(III) oxide to iron by aluminium.

$$2Al(s) + Fe_2O_3(s) \rightarrow Al_2O_3(s) + 2Fe(s)$$

Calculate the mass of aluminium that is needed to react completely with 10.0g of iron(III) oxide.
[Atomic mass of: Fe = 55.8; O = 16.0; Al = 27.0] [2 marks]

b. 0.765 g of an impure sample of calcium carbonate was dissolved in 25.0 cm^3 of 1.00 mol/dm^3 hydrochloric acid. The resulting solution was made up to 250 cm^3 in a calibrated flask. 25.0 cm^3 of this solution were neutralised by 24.35 cm^3 of 0.050 mol/dm^3 sodium hydroxide. What is the purity of the calcium carbonate?
[Atomic mass of: Ca = 40.1; C = 12.0; O = 16.0] [4 marks]

c. In each of the following reactions, identify whether the underlined species has been oxidised, reduced or neither. [4 × ½ mark]

(i) $\underline{Al(s)} + \frac{3}{2}Br_2(l) \rightarrow AlBr_3(s)$
(ii) $2Mg(s) + \underline{TiO_2(s)} \rightarrow 2MgO(s) + Ti(s)$
(iii) $\underline{Ag^+(aq)} + Cl^-(aq) \rightarrow AgCl(s)$
(iv) $\underline{Cl_2(aq)} + SnCl_2(aq) \rightarrow SnCl_4(aq)$

d. From the given information below,

$A + B \rightarrow C + D$ $\Delta H_f = +100$ kJ
$C + D \rightarrow E$ $\Delta H_f = -50$ kJ

calculate the ΔH_f for each of the reactions: [4 × ½ mark]

(i) $C + D \rightarrow A + B$
(ii) $2C + 2D \rightarrow 2E$
(iii) $2C + 2D \rightarrow 2A + 2B$
(iv) $A + B \rightarrow E$

Continued.....

Question 2 [10 marks]

a. Refer to the element below:

$$_{22}\mathbf{Ti}$$

(i) Write the full electron configuration of this element. [1 mark]
(ii) Draw the orbital diagram for this element. [1 mark]
(iii) Indicate the number of unpaired electrons present in this element. [½ mark]
(iv) Name the group in the Periodic table where this element is found. [½ mark]

b. The difference in energy between the second and third orbit of the hydrogen atom is 3.03×10^{-19} J. Calculate the frequency of the emitted light when electron transition takes place between these two levels. [1½ marks]
[Planck's constant, $h = 6.63 \times 10^{-34}$J·s]

c. Which of the following atoms and ions are isoelectronic? [1½ mark]
[Atomic number: S = 16; B = 5 O = 8; Ca = 20; Cl = 17; Al = 13; N = 7; Mg = 12]

S	O^{2-}	Cl	N^{3-}
B	Ca^{2+}	Al^{3+}	Mg

d. Identify the group number (1A-8A) in the periodic table to which the described elements (X, Y, P and Q) belong, in each of the following cases: [4 × ½ mark]

(i) X commonly forms the ion X^{2-}.
(ii) Y reacts with water according to the equation
$Y(s) + 2H_2O(l) \rightarrow Y(OH)_2(aq) + H_2(g)$
(iii) P exists as molecules, P_2; its hydride has the formula HP.
(iv) Q is a metal which reacts with oxygen to produce the peroxide, Q_2O_2.

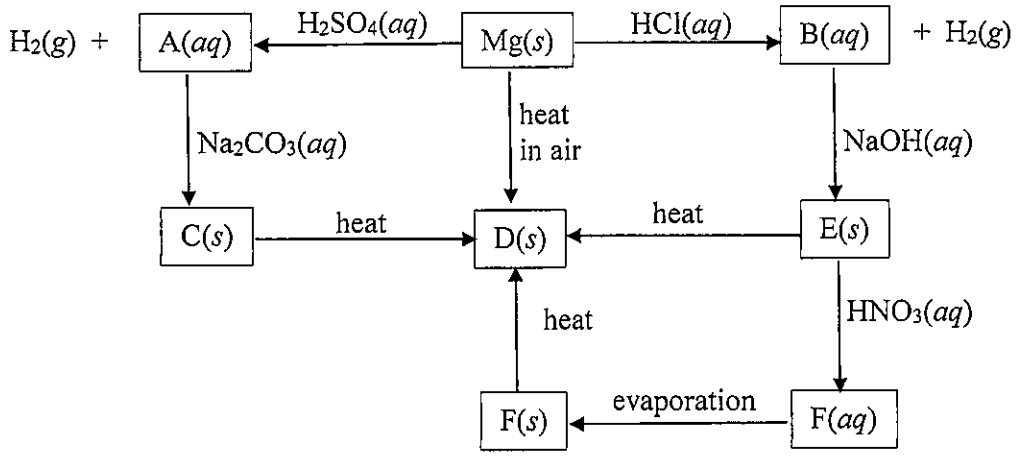
e. The following compounds form oxoacids when they dissolve in water. Show the reactions involved by writing balanced equations for each of them.

(i) N_2O_5 [1 mark]
(ii) P_4O_{10} [1 mark]

Continued.....

Question 3 [10 marks]

a. Magnesium is the eighth most common element in the Earth's crust. The metal is widely used in alloys which are light and strong. Some reactions of magnesium and its compounds are shown in the reaction scheme below. Identify, by name or formula, compounds A to F. [6 × ½ mark]



b. Describe the shape and indicate the number of σ bonds and π bonds in the following molecules. [2 × 1½ marks]

(i) hydrogen cyanide, HCN
(ii) methanal, CH_2O

c. Draw the Lewis dot structures to represent the formation of the following ionic compounds:
(i) Na_2O [1 mark]
(ii) $PbCl_2$ [1 mark]

d. Compare the Lewis structure of BF_3 and NF_3. Why do these molecules have different shapes? [2 marks]

Continued.....

Question 4 [10 marks]

a. Describe all the intermolecular forces that can occur between the molecules in each of the following liquids, and predict which will have the lowest boiling point, and which will have the highest. [2½ marks]

A $CH_3CH_2CH_2CH_3$ **B** CH_2ClCH_2OH **C** CH_3CHCl_2

b. Explain the following observations, based on your understanding about factors which influence the reaction rate. [3 × 1 mark]

(i) Potatoes can be cooked more quickly by cutting it up into long strips.
(ii) Meat gets cooked faster when a pressure cooker is used.
(iii) Iron structures facing the seafront corrode more quickly.

c. The rate law for the reaction:

$H_2 + I_2 \longrightarrow 2HI$ is Rate = $k[H_2][I_2]$.

How would the rate of reaction change if: [4 × ½ mark]

(i) $[H_2]$ is doubled?
(ii) $[I_2]$ is doubled?
(iii) both $[H_2]$ and $[I_2]$ are doubled?
(iv) $[H_2]$ is doubled and $[I_2]$ is halved?

d. The decomposition of trichloromethanoic acid into CO_2 and trichloromethane is a first order reaction with a half-life of 3.15 hours at 80°C. Calculate the fraction of trichloromethanoic acid remaining after a time interval of 12 hours at 80°C. [2½ marks]

Continued.....

Question 5 [10 marks]

a. (i) Boron nitride, BN_3, melts at approximately 3,000°C under high pressure. This material is almost as hard as diamond. What type of crystals is this? [½ mark]
(ii) Crystals of elemental sulfur are easily crushed, and melt at 113°C. Liquid sulfur does not conduct electricity. What type of crystals is this? [½ mark]
(iii) State two properties of an amorphous solid. [1 mark]

b. What is the effect of increasing the concentration of hydrogen ions on the following reaction? [1 mark]

$$CH_3COO^- + H^+ \rightleftharpoons CH_3COOH$$

c. Consider the following equilibrium, explain why removing water leads to more ester being formed in the equilibrium mixture. [1 mark]

$$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$$

d. What is the effect of raising the temperature on the following equilibrium? [1 mark]

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H = -12 \text{ kJ/mol}$$

e. Write the expression for K_c for each of the following reactions. [2 × 1 mark]

(i) $I_2(aq) + I^-(aq) \rightleftharpoons I_3^-(aq)$

(ii) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

f. Some 0.10 mol/dm^3 sodium hydroxide is added to 25.0 cm^3 of 0.10 mol/dm^3 hydrochloric acid. Calculate the pH of the resulting solution after the addition of: [2 × 1½ mark]

(i) 24.9 cm^3 of alkali
(ii) 50.0 cm^3 of alkali

End of Paper